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CANADIAN PATENT

ELECTRIC CONDENSERS

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This invention relates to the production of electrically conductive elements and electrostatic condensers utilising such conductive elements.

In accordance with the present invention I provide a method of forming an electrically conductive element which comprises the steps of depositing a porous metal layer upon a porous flexible base, impregnating the metal layer with dielectric so that the dielectric extends in all directions in the metal layer and removing the base before or after impregnation of the metal layer.

In its simplest form, the invention provides an electric conductor of a strip or other planar form; such a conductor can be used for various applications where such shape can be employed, including electric coils and transformers, and in electric condensers. In making this conductor a base material is coated with particles of metal. The base must be porous and flexible and is preferably fibrous, and for this purpose there may be used paper or asbestos fibre sheet material. A suitable material is soft kraft condenser paper; hard calendered, or super-calendered paper is not very suitable since it is difficult to obtain adequate adhesion of the subsequently applied metal layer. The base preferably has a thickness which lies in the range of 0.0002 to .002 inches.

One or both sides of the base material is next coated with a metal layer of a thin, flexible porous nature; such a layer can be produced by means of a Schoop type metal spray gun or metal powder spray gun, or other metallising apparatus for depositing finely divided metal particles in either solid or molten condition. Alternatively a thin layer of metal powder can be deposited on the base, the deposit being then sintered in a vacuum, or non-reactive atmosphere and conveniently by high-frequency heating means. The conductor material thus produced is flexible, porous and thin, having a thickness between .001 to .010 inches approximately. The coating material can be applied to the whole or part of the area of the base, on one or both sides as mentioned above,

and one or more wholly or partly overlapping layers of material can be used. It is desirable that the resulting layers should be uniform and should evidence substantial capillarity when subsequently immersed or impregnated with dielectric material as described hereinafter. In the preferred construction of electrodes, the electrodes are sufficiently porous and thin to pass light, and are in the nature of a metallic lattice.

The coated base material is subsequently impregnated with dielectric material, but before this step is carried out the base material can be stripped or otherwise removed from the metallic layer, to leave a wholly metallic strip. Thus the base material can be removed by combustion or solution, or by mechanical separation, the method used depending to some extent on the nature of the base. Where the base has been coated on both sides two strips are obtained by slitting the composite strip along the edge and stripping the two outer coatings from the base. The metal layer or layers after removal of the base is self-supporting and can readily be handled.

The metal layer, before or after removal of the base material may be partly smoothed, before impregnation, by rolling or grinding, but the resultant surface must be minutely rough and must retain its property of porosity. Preferably the surface has a texture giving the feel of fine grade abrasive paper or cloth.

The metal layer is impregnated with a dielectric material which is or can be rendered sufficiently fluid to penetrate and substantially fill the pores of the metallic layer. For this purpose a molten wax, varnish or enamel can be used, or a synthetic molten thermoplastic material such as cellulose acetate. Again, molten phenol-formaldehyde or urea-formaldehyde resin can be used, to set on cooling, or to react to, a solid strong material. Whatever material is used as the impregnant, it should have good dielectric properties.

The dielectric material can be applied in various ways; sheets

r strips can be applied to one or both sides of the metallic layers and then made sufficiently fluid as by heat and pressure, to penetrate the layer.

It is advantageous to apply the dielectric material by a continuous process. Thus, the continuous metal strip may be continuously impregnated and coated with a suitable dielectric in a liquid condition, this coating being subsequently hardened or set, as by baking or heating. Furthermore, the coating itself may have adequate thickness and dielectric strength to act as a separator on winding a coil from the coated metal strip i.e. to physically space and provide electrical insulation between adjacent turns of the coil without the use of paper or other porous spacing or filling means.

Smooth surfaced conductors comprising continuous porous strips of metal particles impregnated with dielectric may be made continuously by passing strip material through a pressurised continuous plastic extrusion machine head and die from which it will emerge with a uniform coating of dielectric.

The resulting material is somewhat as shown in Figure 1 of the accompanying drawing, which is a fragmentary cross-section through a conductor, Fig. 2 being a fragmentary cross-section of an assembly according to the invention. Fig. 1 shows a sheet 10 consisting of porous metal throughout insulated on both sides by a suitable dielectric material 11, 12 in which the metal strip 10 is completely embedded. The dielectric or insulating material 11 is solidified while in contact with the metal strip 10 whereby an intimate bonding between the dielectric and metal strip is obtained with the dielectric extending through holes in the metal strip, forming a tight jointtherewith.

In employing the present invention in the manufacture of an electrostatic condenser, two or more metallic layers with interposed dielectric layers, are formed into an integral composite assembly by the addition of dielectric material.

Figure 2 shows a fragmentary cross-section of an assembly of

this kind, made by superimposing alternate strips of porous metal sheets 21 and porous dielectric sheets, such as paper or asbestos 22. The associated sheets 21 and 22 are bonded together by means of a dielectric material 23 that substantially covers the surfaces of the sheets and extends into and through the voids, recesses or holes extending into and through the porous parts so as to produce an integral or unitary structure the components of which are permanently bonded together by means of the dielectric 23.

Where an electrode in accordance with the invention is rolled or stacked, as in the manufacture of a condenser, it may be more convenient to introduce, or to render fluid, the dielectric after such rolling or stacking. In this case, vacuum impregnation can be employed with advantage. However, in some instances, it may be satisfactory merely to force liquid dielectric into contact with the various sheets without evacuating the air surrounding the same, but in general, the dielectric 23 is in liquid form at some period when associated with the sheets 21 and 22 and is thereafter set or hardened by physical and/or chemical action to obtain the permanent unitary electrode assembly. By using a dielectric material which hardens great structural strength is obtained in the finished device since the dielectric extends practically throughout the conductive electrode itself and is not a mere surface application. The dielectric plastic when set reinforces the electrode and spacers and makes a completely unitary structure thereof.

Dielectrics which are fluid at ordinary temperatures may be used, for example with electrodes for electrostatic condensers, but of course such dielectrics do not hold the spacers and electrodes together physically and make the strong unit attainable by using hardening dielectrics. Whatever type of dielectric is used, the flow characteristics of the dielectric in fluid condition and the porosity of the electrodes must be such that the molten or liquid dielectric will penetrate and flow into the porous electrode without disruptive force.

One method of making condensers which is satisfactory in practice is to stack two porous metal strips as described above with two porous paper strips, alternating the strips; this stack is then wound helically and the winding so made is held by a strip of adhesive tape applied to the lap of the winding. The winding is placed in vacuum chamber and evacuated and with the application of heat if desired. When sufficiently evacuated the winding is impregnated with a dielectric material such as one of those mentioned above. If urea formaldehyde resin is used, the winding may be heated to about 300 to 320°F. After impregnation the impregnated winding may be separated from the body of molten dielectric bonding and impregnation medium and chilled. This impregnation may be accomplished in a mould.

Non-inductive windings can also be used, with windings offset so that an electrode of the one polarity is exposed at one end of a condenser and an electrode of different polarity at the other end.

It may be mentioned that in winding electrodes, the electrodes wind more easily than smooth foil electrodes since they do not readily slip but stay in place due to their somewhat rough surface.

The terminals for the electrodes may be attached mechanically or may consist of extensions of the porous electrodes themselves impregnated with the molten dielectric whereafter they are strong and conductive being composed of porous metal impregnated with dielectric. Soldering to such terminals or extensions can be accomplished.

The article when impregnated can be provided with a casing of the same material as used for the impregnation.

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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method of forming an electrically conductive element comprising the steps of depositing a porous metal layer upon a porous flexible base, impregnating the metal layer with dielectric so that the dielectric extends in all directions in the metal layer and removing the base.

2. A method of forming an electrically conductive element which comprises the steps of depositing a porous metal layer upon a porous flexible base, removing the layer from the base and impregnating the layer with dielectric material so that the dielectric material extends in all directions in the metal layer, the resultant impregnated layer being encased in the dielectric material.

3. A method of forming an electrostatic condenser having two electrically conductive elements which comprises the steps of depositing a porous metal layer upon a porous flexible base, removing the layer from the base, repeating these steps to obtain another porous metal layer, superimposing the two layers thus obtained, interleaving them with a porous insulating layer, impregnating the layers with liquid settable dielectric material and solidifying the dielectric material in intimate bonding relation to the associated layers.

4. A method of forming a condenser according to claim 3, in which the layers are impregnated with a hot liquid dielectric material in an evacuated atmosphere and the dielectric material is cooled to solidify it.

5. A method according to claim 3 in which each metal layer is formed by spray depositing molten metal particles on an insulating porous backing.

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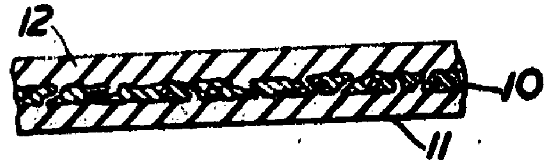

FIG. 1.

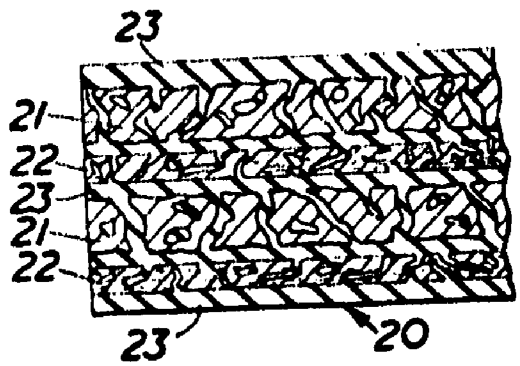

FIG. 2.